

Children's Exposure to Diesel School Bus Emissions

David R. Brown Sc.D.

EHHI/NESCAUM

John Wargo Ph.D.

Yale University

Air Toxics Exposure Assessment

San Francisco CA.

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Project description

- Evaluate personal exposure methodology
- Estimate distribution of school day exposures to diesel emissions (PM, VOCs, & Carbonyls)
- Identify factors associated with short term elevations
- Compare exposures with Connecticut ambient air levels

Basic Study

Sample collection protocols

- **Personal samples:**

...Morning bus ride.....School day.....Afternoon bus

- A. PM 2.5 or 10, real time samples
- B. Aldehyde integrated sample
- C. VOCs integrated sample

- **Background samples:**

- *.....School day only.....*

- A. Aldehyde integrated samples
- B. VOCs integrated samples

- **Instantaneous samples:**

...Morning bus Afternoon bus

- A. VOCs instantaneous grab samples outside bus

- **Activity recording:**

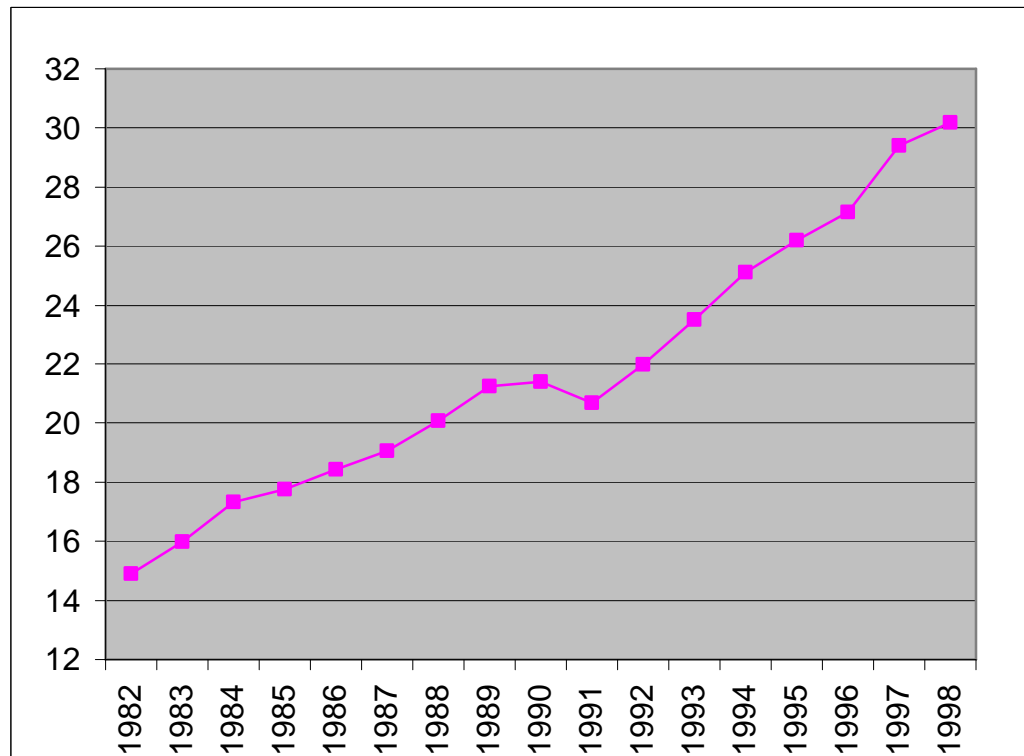
...Morning bus ride.....School dayAfternoon bus

- A. Activity logs prepared by graduate student observer

Rationale

- Phase 1 Personal sampling:
 - 15 student, 15 different schools and 15 days
 - Full day sample collections
 - Activity logs
- Phase 2 Measure surrogate bus routes:
 - Rural area with multiple runs
 - Vary the number of stops and hills
 - Vary the idling times and bus configuration
- Comparisons for hypotheses generation

U.S. Trends in Diesel Fuel Consumption
Billions of Gallons Per Yearⁱ



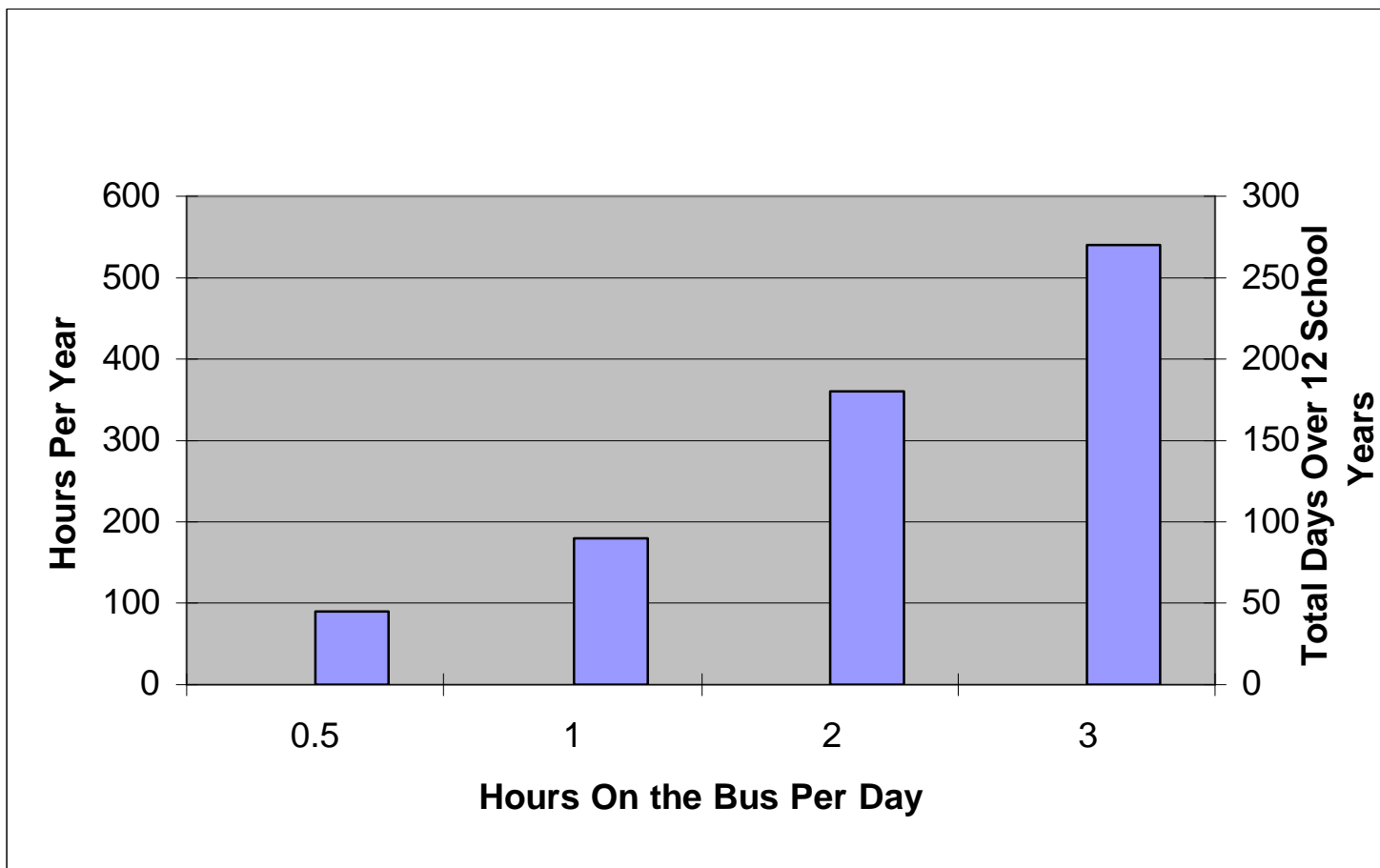
Source: US Department of Transportation. FHA 1998.

Connecticut tax on diesel fuel is now \$0.18 per gallon. Only 15 states have lower diesel taxes, and New York, Massachusetts and Rhode Island—Connecticut's neighbors, have higher taxes.ⁱⁱ

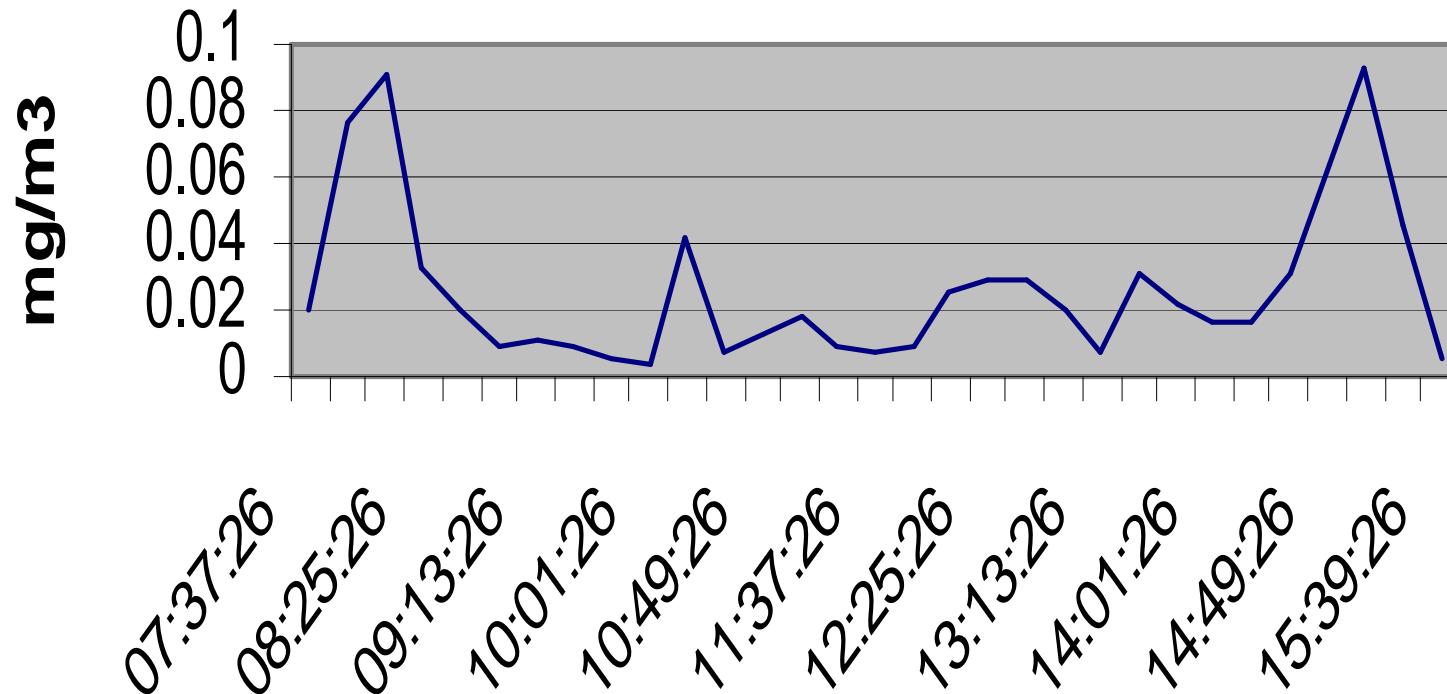
ⁱUSDOT. FHA. 1998.

ⁱⁱ Davis, S. 2001. Transportation Energy Data Book. Oak Ridge National Laboratory. USDOE.

Hours Spent on School Buses
Per Day, Year, and Over 12 Years of School

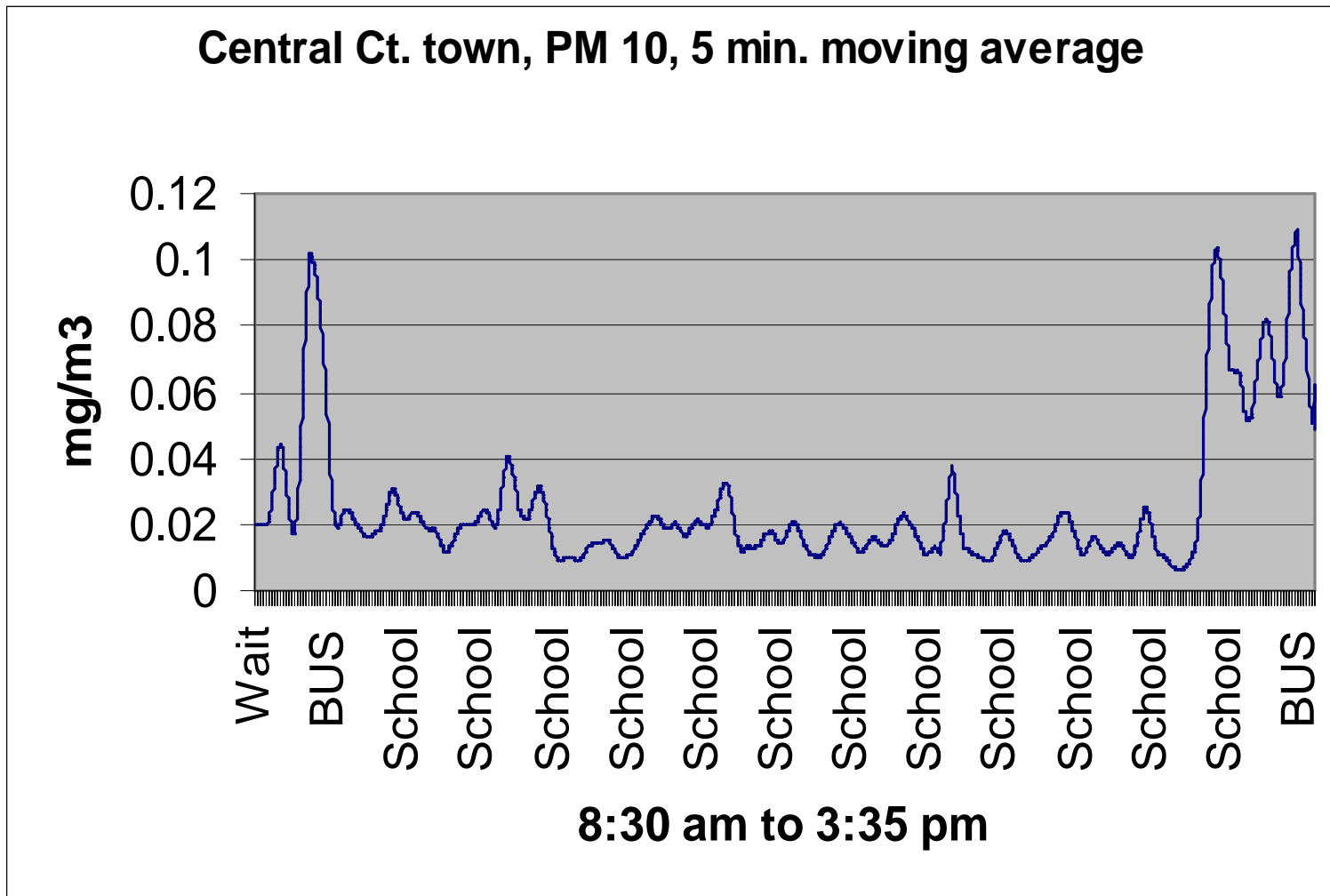


School child exposure, continuous nephelometer 15 minute averages

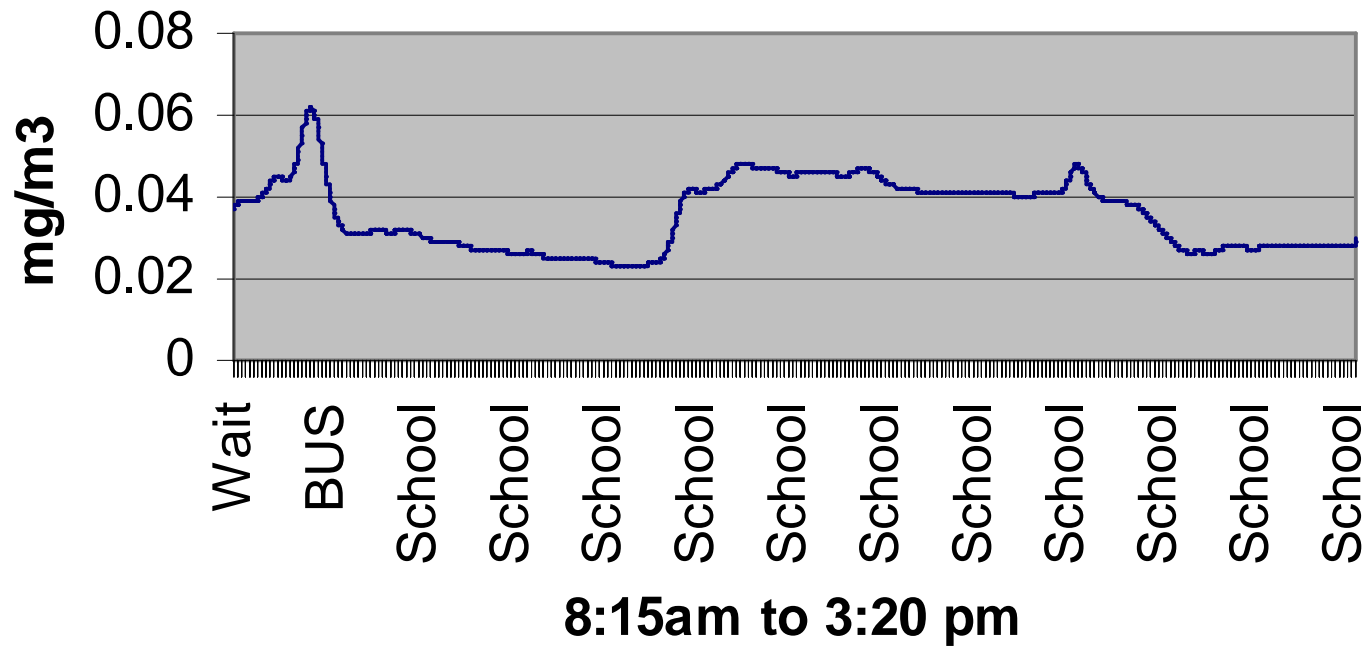


Bus 7:30 to 8:40 and 2:30 to 3:40

School child exposure, continuous nephelometer

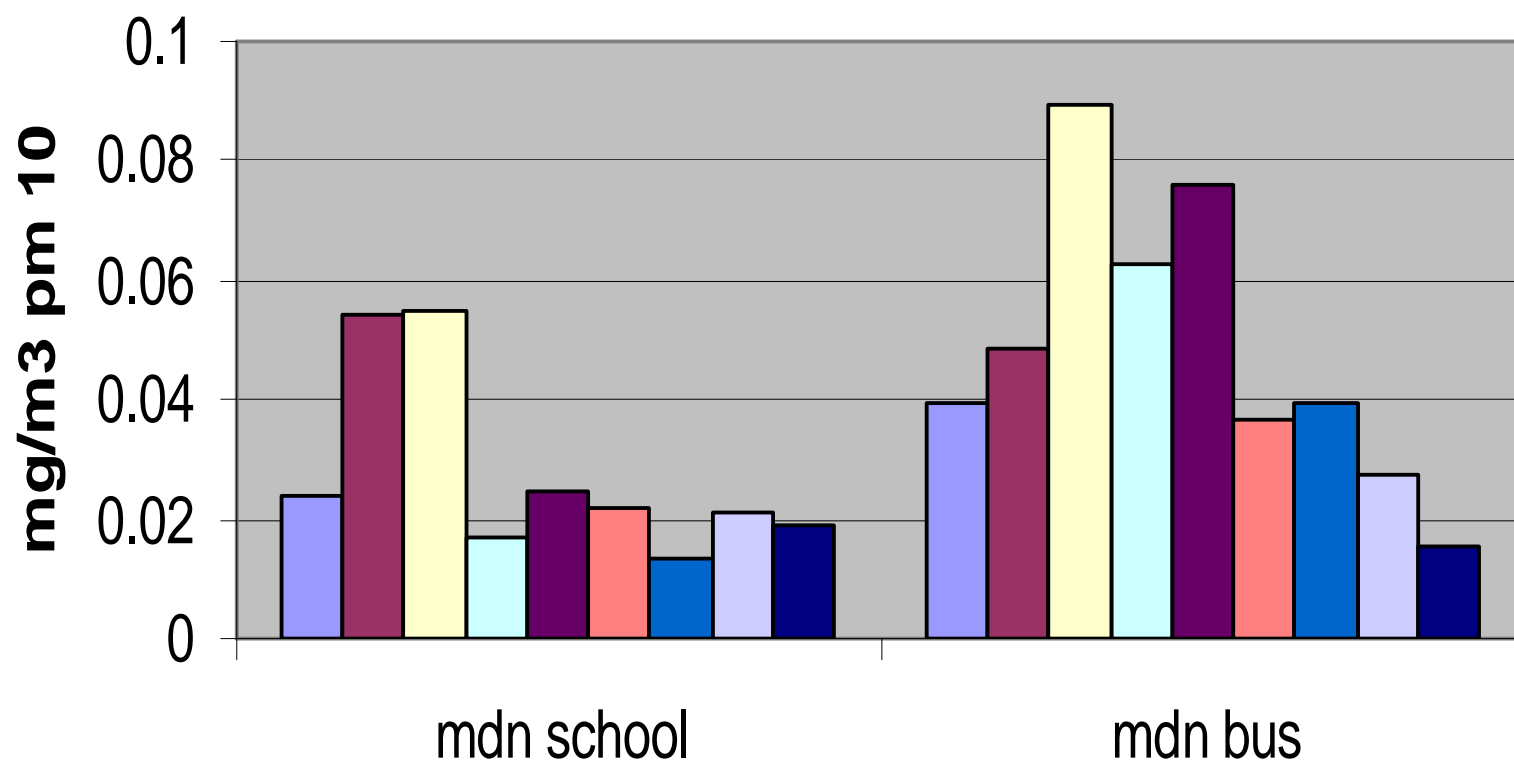


PM 2.5 Ct. Coastal Town (5min moving average) 17 minute bus ride

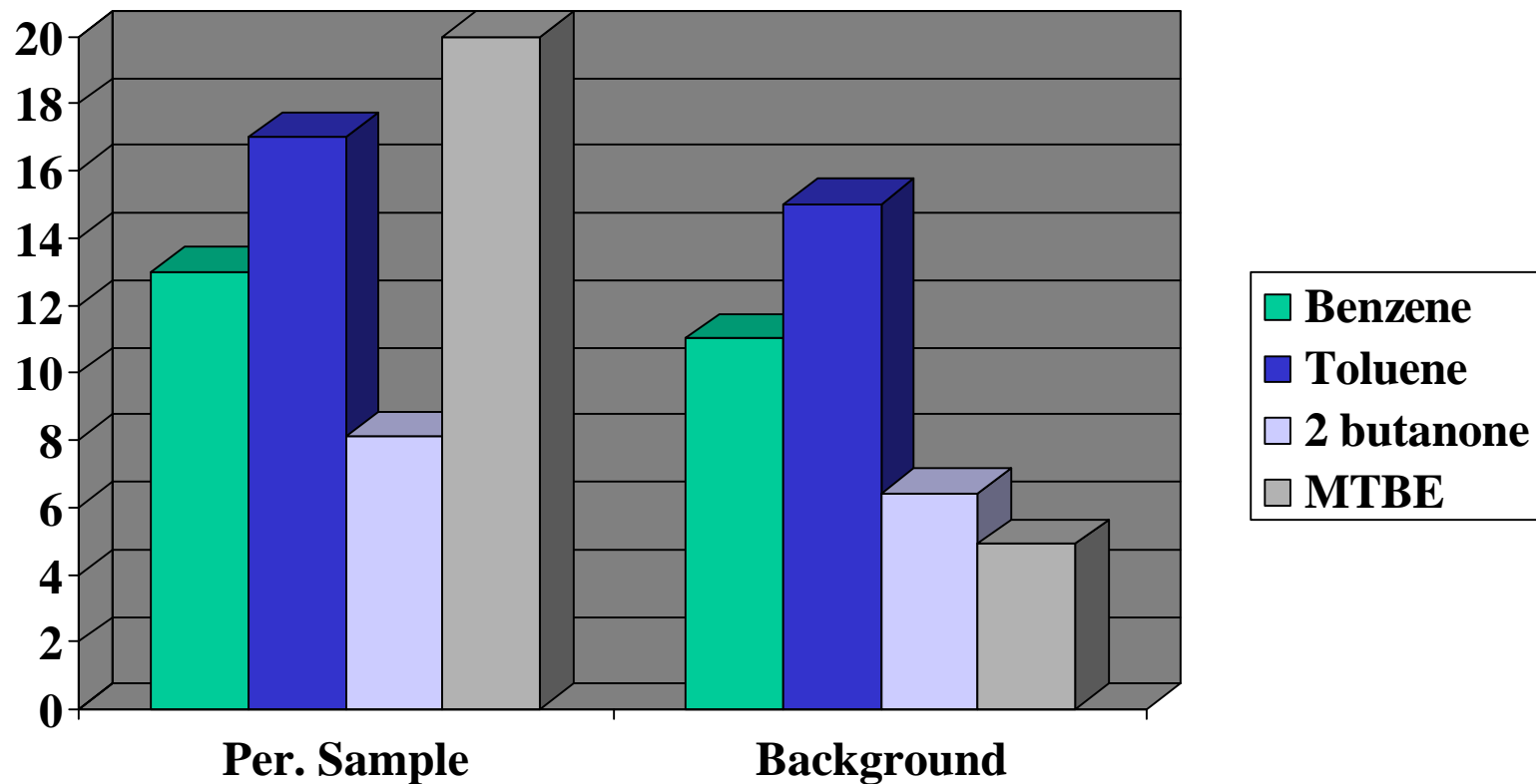


School Child Exposure Continuous Nephelometer

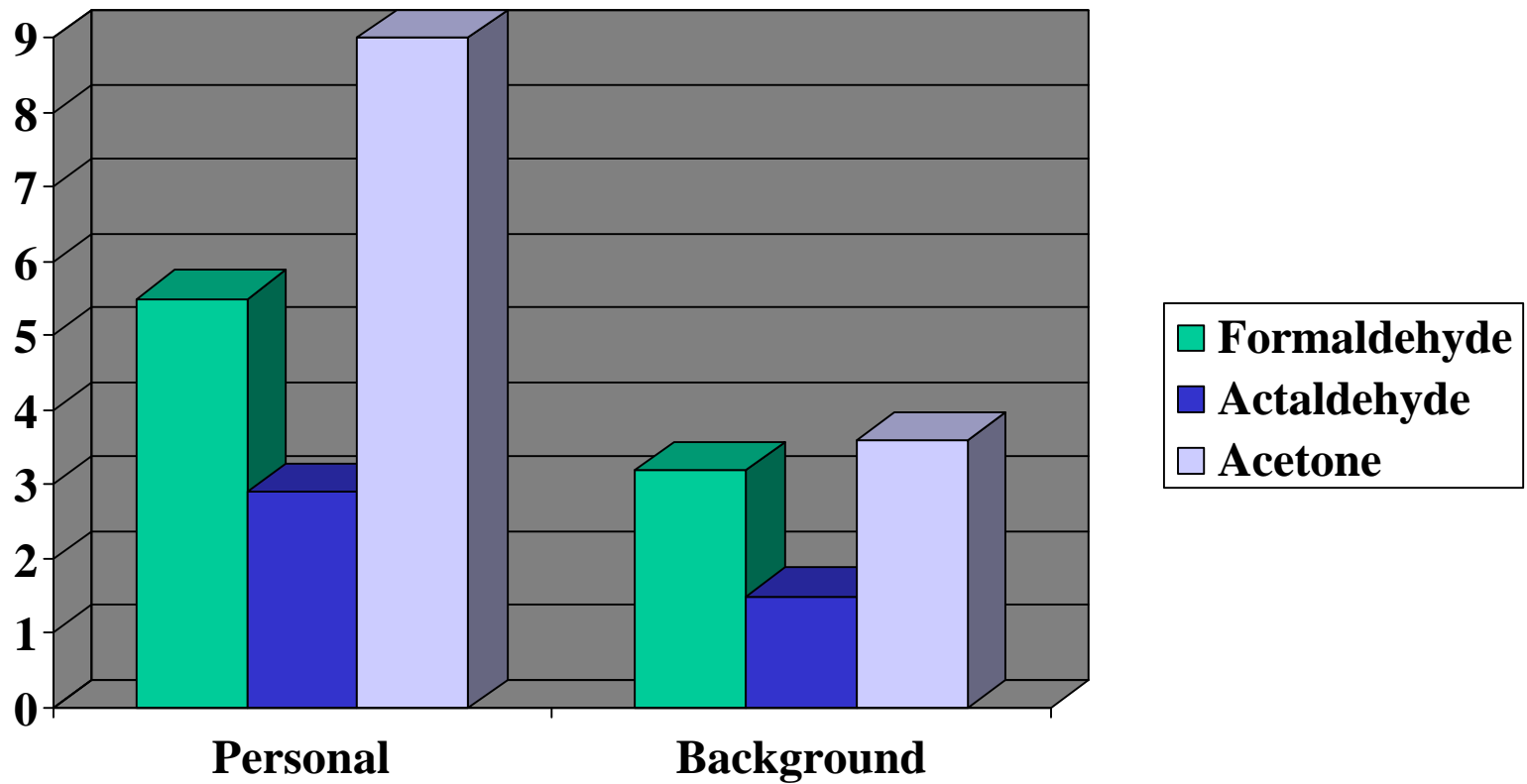
MDN PM10 schools and buses



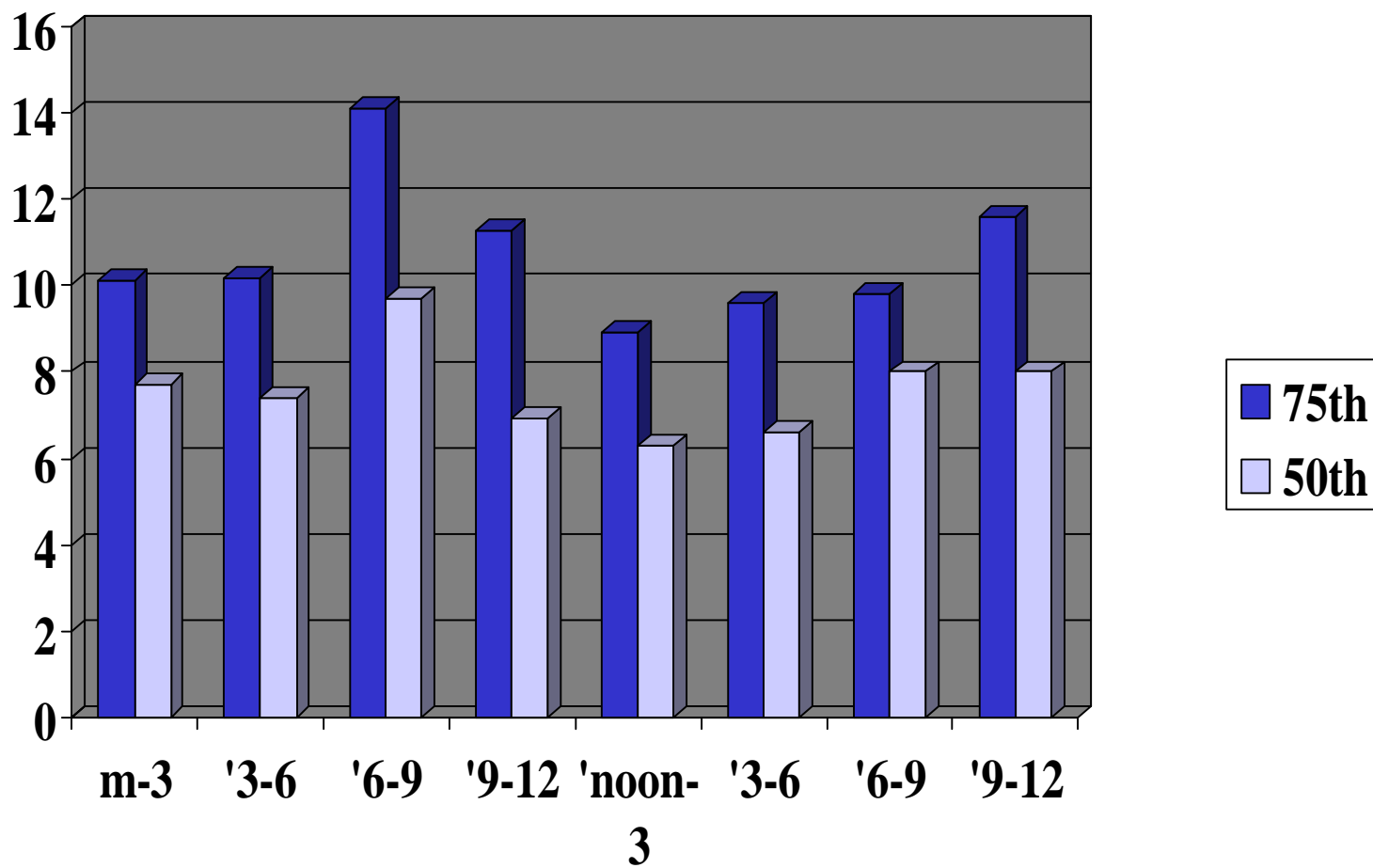
Average VOCs (ug/m³)



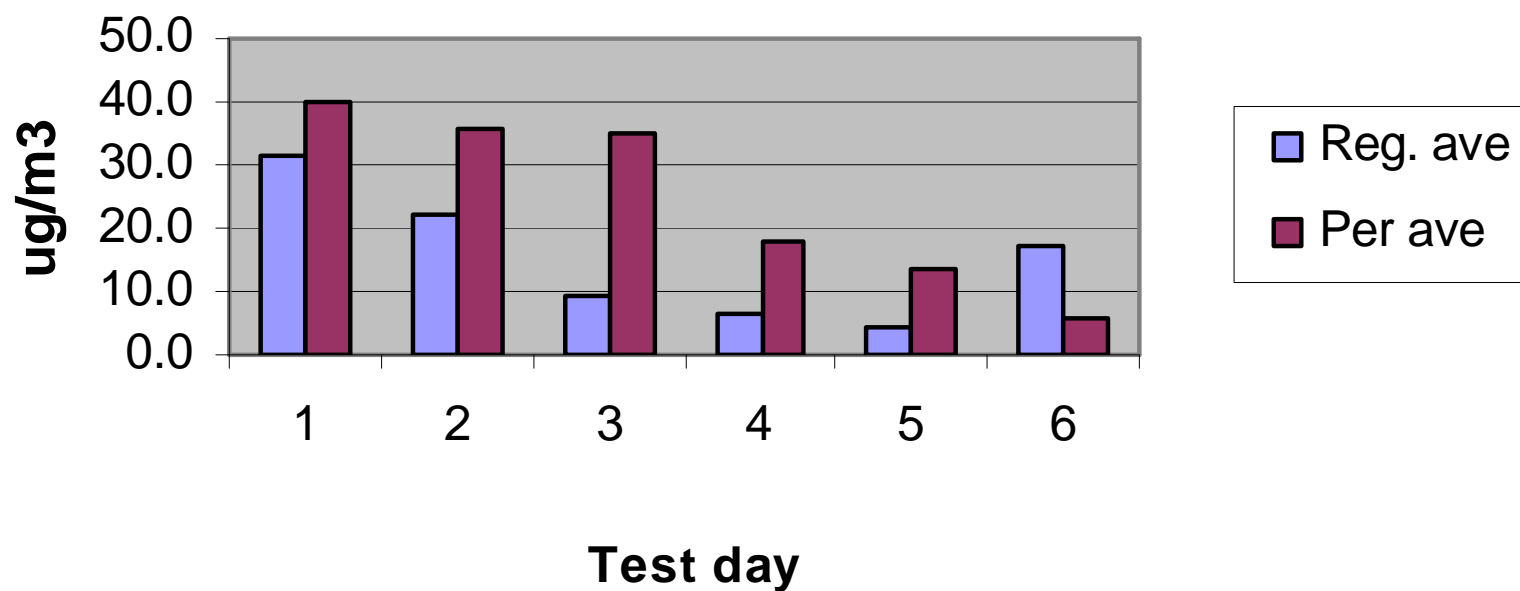
Average Aldehydes (ug/M3)



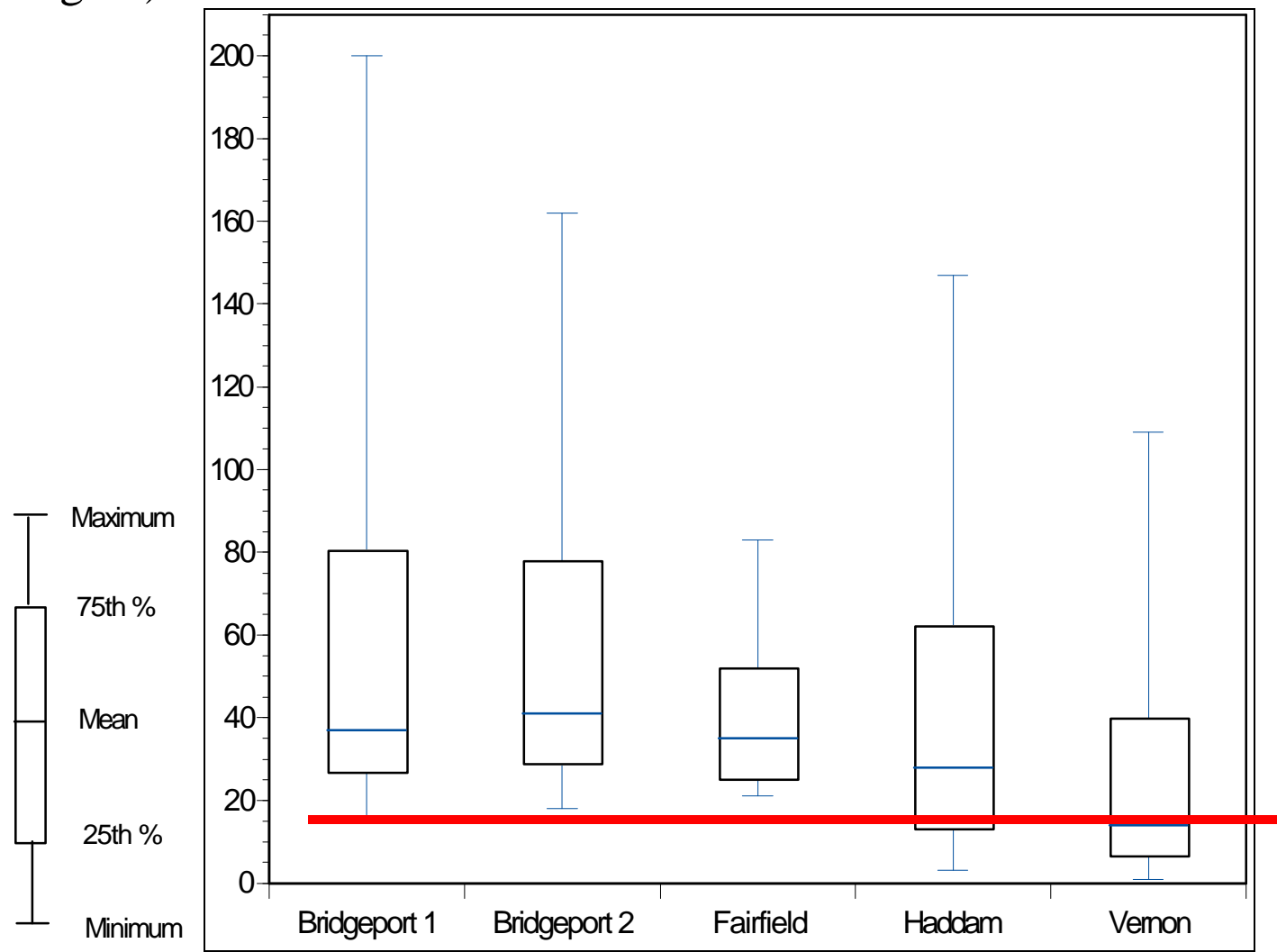
April pm 2.5 by 3 hour intervals



Comparison of PM2.5 student sample and in regional air monitors from 7 am to 4 pm



Individual Student Exposure to Particulates (PM 2.5 ug/m³)



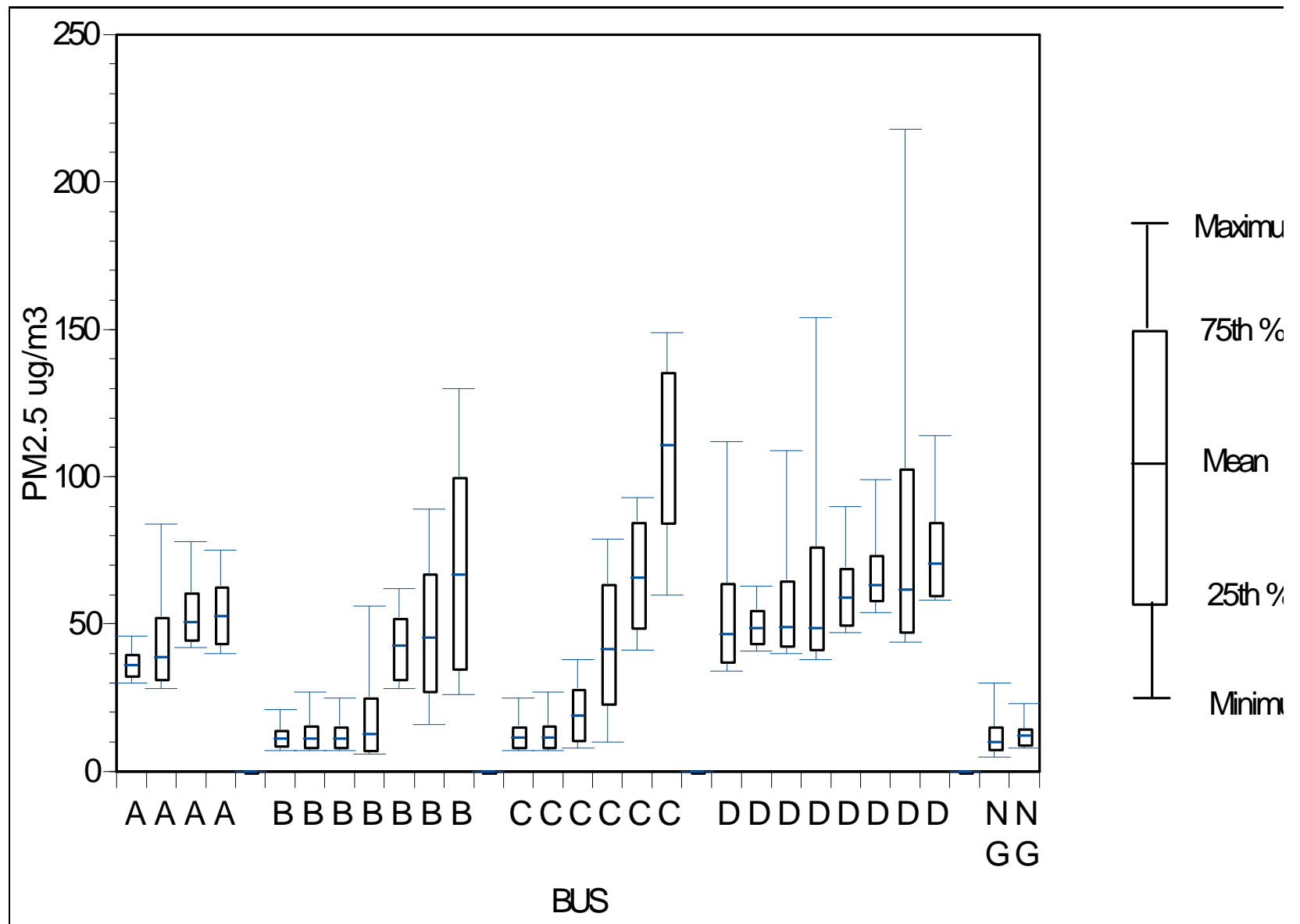
Red Line Locates Average Daily Connecticut Urban PM 2.5 (12.5 ug/m³)

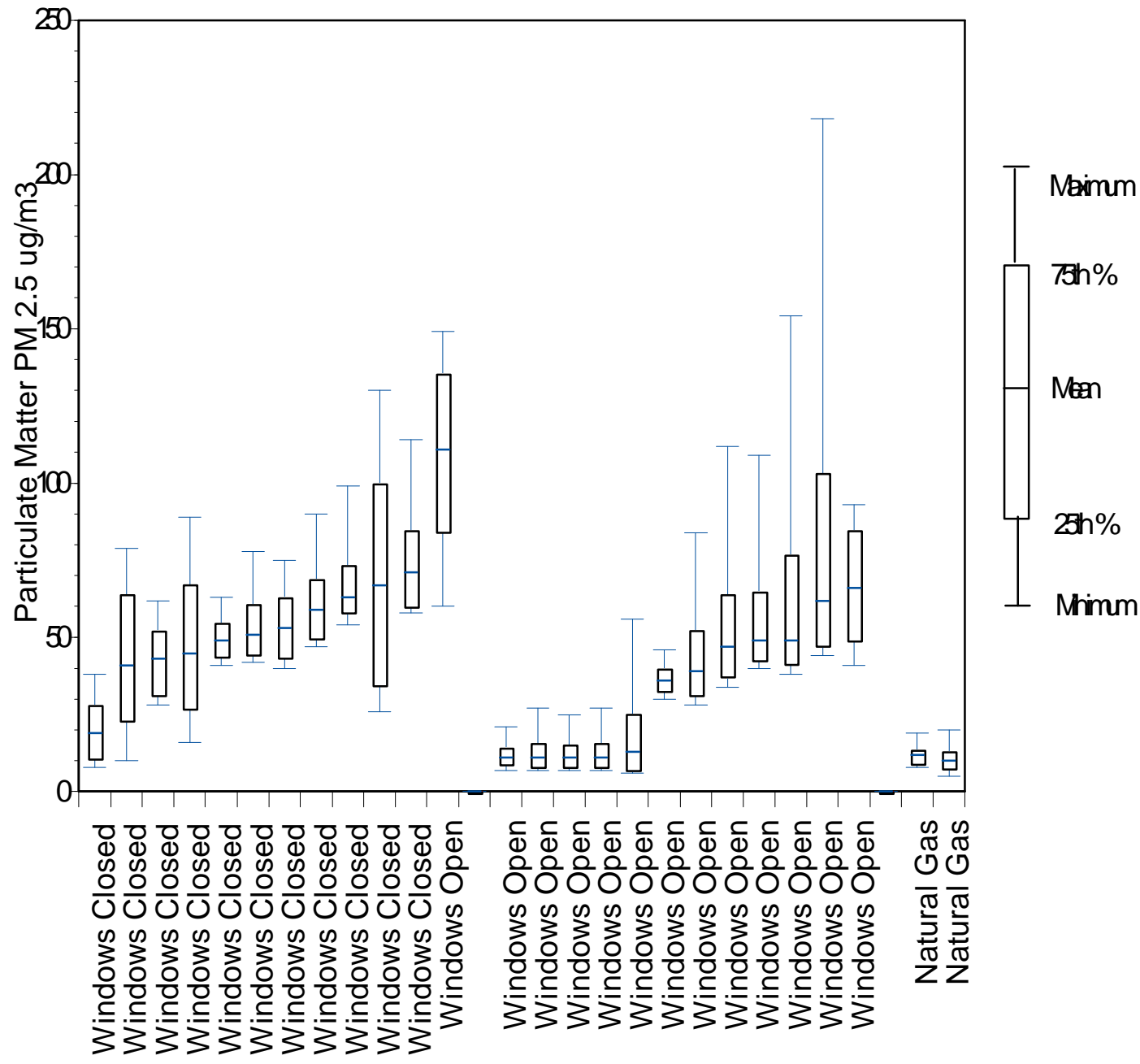
Phase 2

Surrogate Bus Routes factors that increase exposures

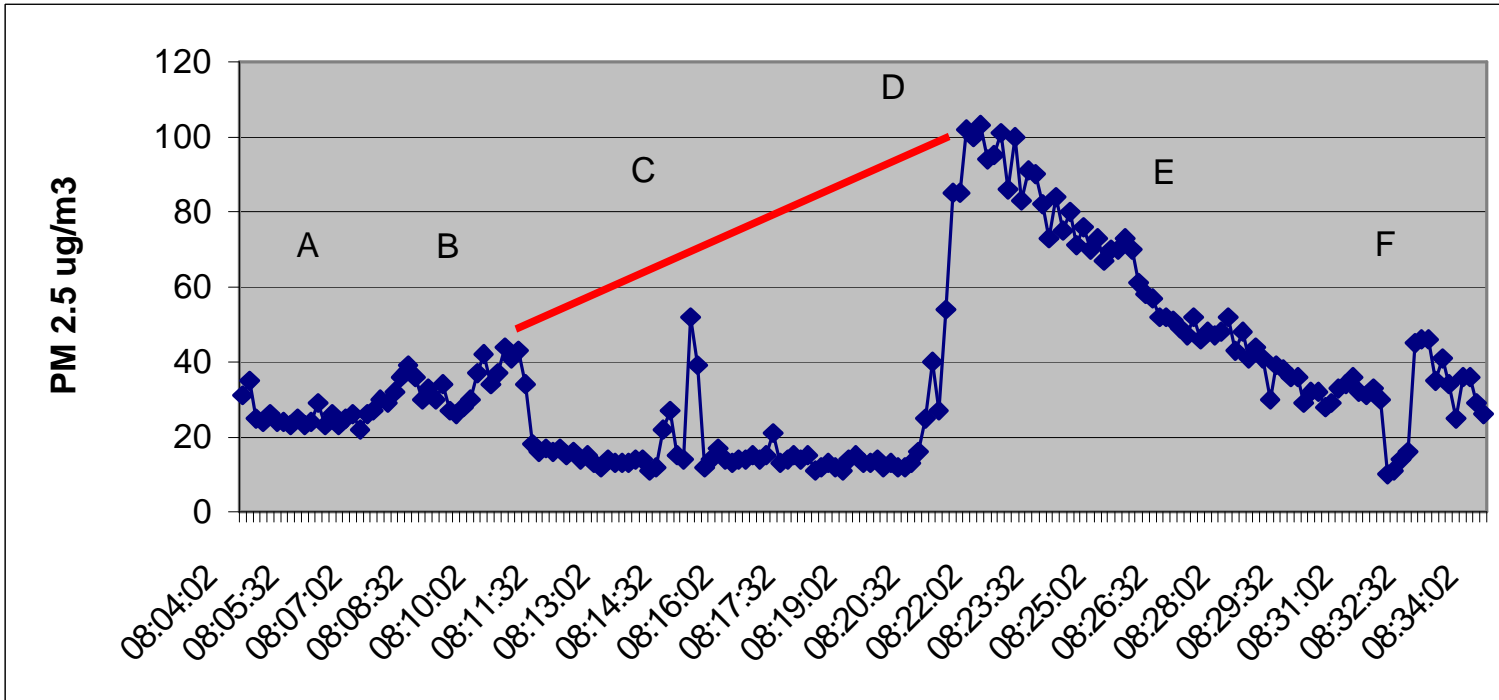
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Range of Particulate Concentrations Grouped by Bus





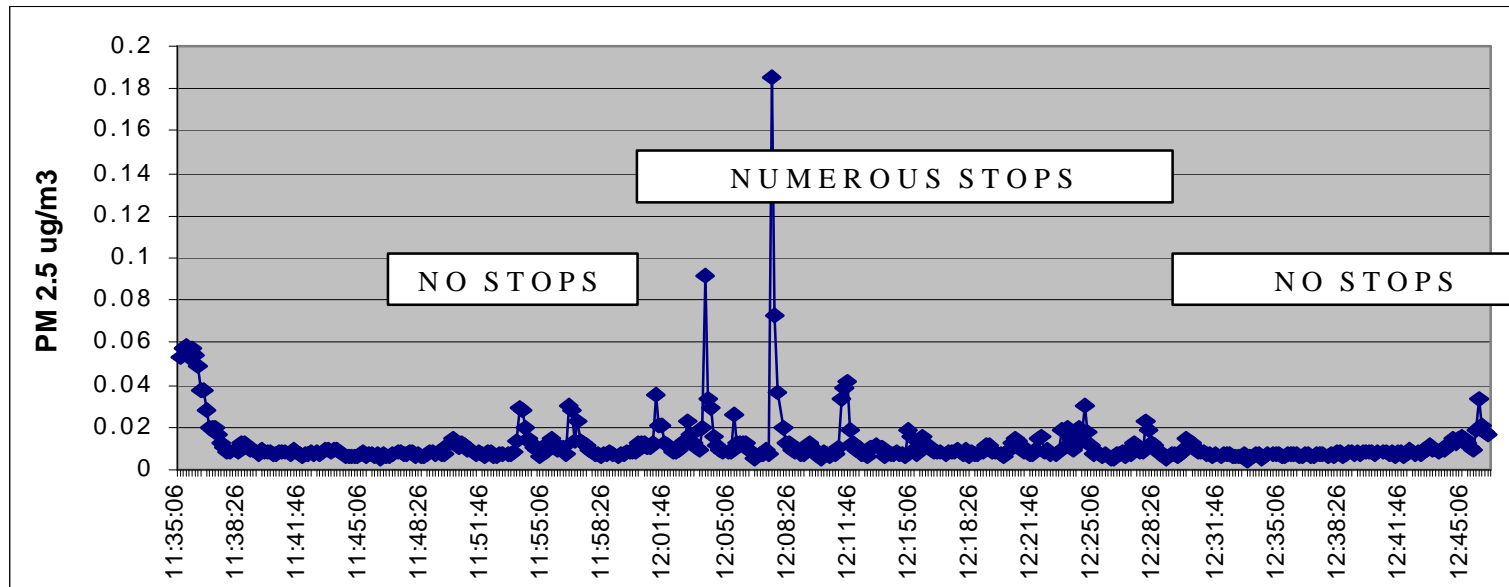
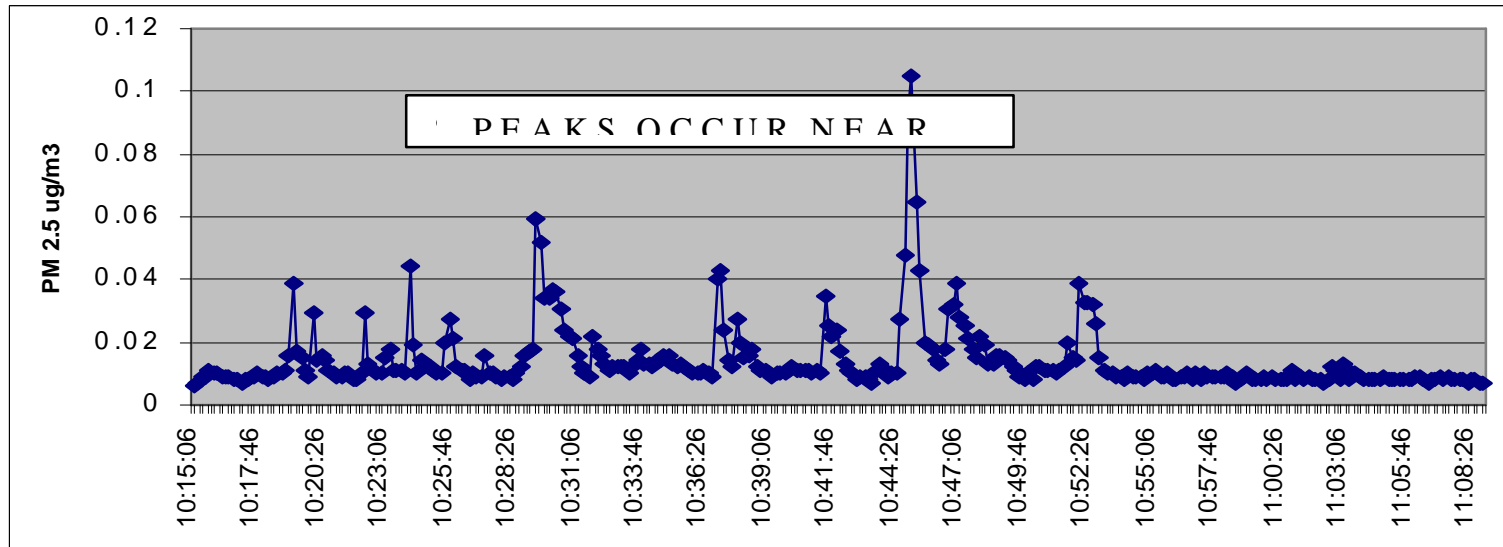
Idling Effect:
PM_{2.5} Accumulation and Ventilation



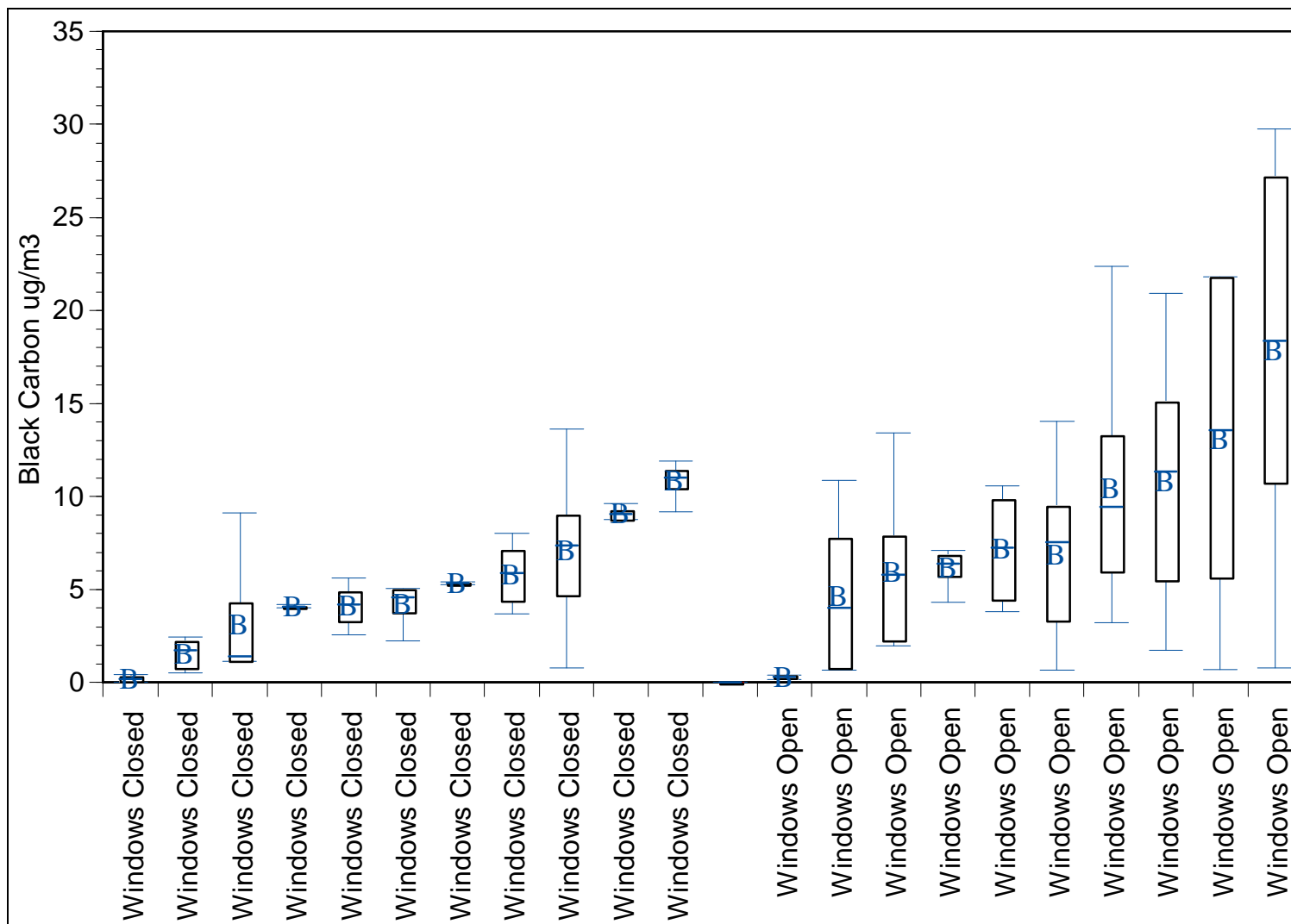
- A: Bus Arrives at School Transfer Station and Begins Idling
- B: Student Exits Bus with Personal Monitor and Waits to Reenter
- C: Steady Interior Increase in PM_{2.5} Concentrations
- D: Student Reenters Bus 10 Minutes Later With PM_{2.5} Higher by 5X.
- E: Steady Ventilation and Reduction of PM_{2.5} En Route to School.
- F: Student Exit Bus At School.

Red Line: Steady Increase in Interior Particulates

Bus Stops Increase Interior PM 2.5



Carbon Levels in Idling Buses Storrs Study



Lessons Learned

- Real time personal monitors show the wide temporal differences in exposures.
- Ambient air contribution is an affect depending on time of day and weather
- 6 VOCs and 4 carbonyls are present in al personal samples.
- Idling buses are a major contributor to PM during school days

The out door environment, air pollution, and public health impacts- current needs.

- Need to more fully characterize environmental pollution.
 - criteria pollutants
 - toxic pollutants
 - impacts of global, national, regional, and local pollution
- Need to merge public health information with our understanding of environmental exposure(s).
- Need stronger collaboration between environmental and public health agencies and advocates.
- Need to consider regulatory and policy action without an absolute causal association.

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www.ehhi.org